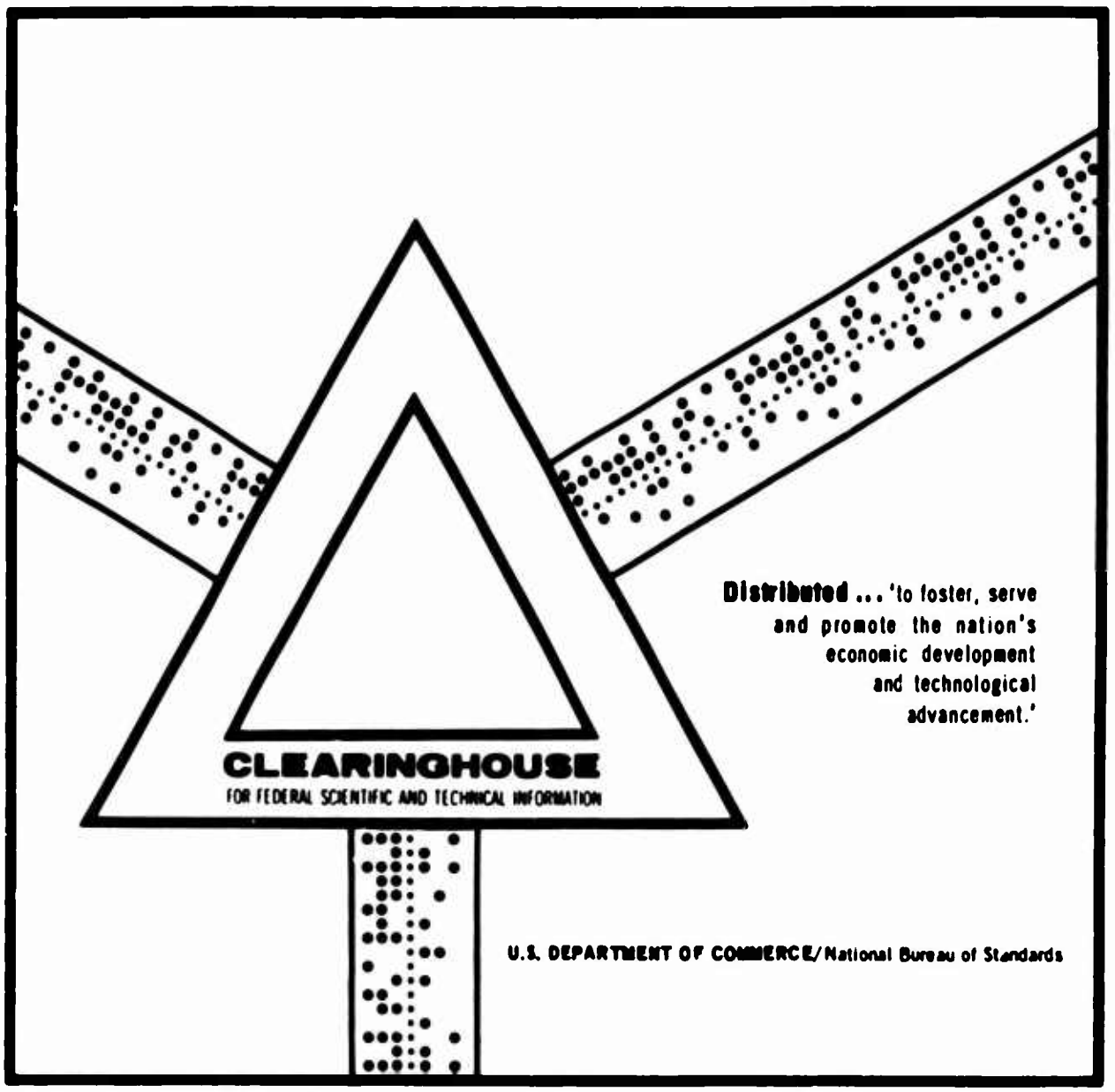
PICTORIAL METHODS OF INSTRUCTION FOR THE M-73 MACHINE GUN AND THE CALIBER .45 AUTOMATIC PISTOL

J. Roger Ware, et al

Human Resources Research Organization
Alexandria, Virginia

December 1969



HumRRO

Consulting Report

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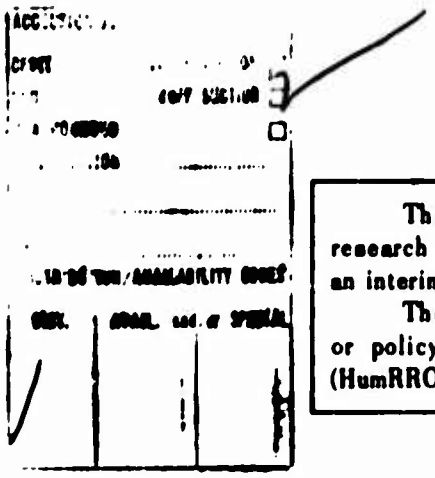
HUMAN RESOURCES RESEARCH ORGANIZATION



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Human Resources Research Organization
300 North Washington Street
Alexandria, Virginia 22314

Consulting Report

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J. Roger Ware, Elmo E. Miller,
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December 1969

I. RECON, Work Sub-Unit III, "Preparation of Training Guidelines and Improved Training Methods."
II. Technical Advisory Service provided for "Pistols and Revolvers" (FM 23-35/AFM 15-70), prepared by United States Army Armor School (March 1968).

HUMAN RESOURCES RESEARCH ORGANIZATION
HumRRO Division No. 2
Fort Knox, Kentucky

PREFACE

Part I of this report describes the development and evaluation of a pictorial programed training aid for disassembly/assembly of the M-73 machine gun. The program was developed to illustrate the translation of a task description into an effective training program. This development was part of RECON, Work Sub-Unit III, entitled "Preparation of Training Guidelines and Improved Training Methods." The overall purpose of Work Unit RECON was the analysis and development of improved training procedures for armored cavalry platoon personnel.

The task description for the pictorial program for the M-73 machine gun was extracted from "The Armored Cavalry Platoon Combat Readiness Check," a research by-product of RECON III. Another by-product is the "Armored Cavalry Platoon Leader's Workbook."

Part II of this report describes the subsequent development of a similar "picture guide" for the disassembly/assembly of the caliber .45 automatic pistol, M1911A1. This effort was undertaken early in 1968 by the US Army Armor School, Fort Knox, in preparing the revised manual, "Pistols and Revolvers," FM 23-35/AFM 15-70, as directed by USCONARC. The purposes of the revision were to update some of the information on maintenance procedures and ammunition, and to prescribe a new procedure for firing courses.

The Project Officer was CAPT Steven Arnold, working under the direction of LTC John P. Heintz, Directorate of Doctrine and Development, Literature and Plans (formerly Doctrine Materiel and Literature). They decided the method used in the M-73 picture guide (prepared for RECON III) would be appropriate for assembly/disassembly of the caliber .45 pistol; so they requested the services of a HumRRO consultant on pictorial programing for the project (the author of Part II of this report).

SUMMARY AND CONCLUSIONS

Objectives

Although thorough task descriptions are available for many armored cavalry platoon tasks, additional work is needed to translate these descriptions into effective training programs. One such task, disassembly/assembly of the M-73 machine gun, was selected from the "Armored Cavalry Platoon Combat Readiness Check" for the research reported in the first part of this report. The objectives of the research were (a) to study the translation of the task description into a pictorial self-instructional training program, (b) to outline the training methods and principles used, and (c) to evaluate the effectiveness of the pictorial program developed.

The objectives of the second part of this report were (a) to describe the development of a pictorial program for the caliber .45 pistol, as an operational effort rather than a research project; and (b) to describe some extensions of the pictorial programing techniques used in developing the manual.

Method and Results

Part I. Known methods and principles are described and utilized in the pictorial program. After the first draft was completed, nineteen subjects were trained and tested individually. The training consisted of two trials (repetitions) of disassembly/assembly of the M-73 machine gun with the pictorial program, and in subsequent testing each man performed the disassembly/assembly without looking at the program. The program was revised three times to improve communication, wherever the Ss did not seem to perform their task with facility.

The results during practice showed much faster performance on Trial 2 than on Trial 1. The subsequent testing revealed further significant improvement in performance time. The mean number of assists given the trainees did not change significantly between the Test and Retest, but the actual number of assists was so small as to be inconclusive. The US Army Infantry School (Fort Benning, Georgia) supplied additional data which confirmed the training effectiveness of the program.

Part II. The methods for developing pictorial programs were subsequently applied to disassembly/assembly of the caliber .45 pistol by the Armor School's Directorate of Doctrine and Development, Literature and Plans, with the technical assistance of HumRRO personnel. This approach resulted in abbreviated forms of task description and program development, with less formal documentation of the process. Some additional techniques of pictorial programing were developed

Conclusions

Effective pictorial programs may be developed by modifying a task

description, such as the one used for the M-73 machine gun, only after obtaining an adequate working knowledge of the task through actual on-job experience or demonstration. The methods of translation from the task description into the programs outlined in this report may need modification for tasks which vary markedly from the weapon tasks studied here. Pictorial programs can be developed by operational personnel with only modest investment of time if they are assisted by someone experienced in the method.

Training Products

The manual entitled "A Pictorial Program for the M-73 Machine Gun," developed as part of RECON III, may be obtained from HumRRO Division No. 2 (Armor).

The pictorial training program for the caliber .45 pistol is incorporated in the revised Army Field Manual, "Pistols and Revolvers" (FM 23-35/AFM 15-70), which will be printed as soon as "firing courses" in the manual have been tested.

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PART I

DEVELOPMENT AND EVALUATION OF A PICTORIAL INSTRUCTIONAL PROGRAM FOR THE M-73 MACHINE GUN

J. Roger Ware and James L. Constantinides

INTRODUCTION

The purpose of this paper is to describe the development and evaluation of a self-instructional training aid. One of the most important questions to ask--and to answer--before developing a sound training program or an instructional unit, is "What am I going to train?" The most valid source is a description of the elements or responses necessary to perform the task. The task descriptions used in developing the present program were taken from the "Armored Cavalry Platoon Combat Readiness Check" (1), prepared by HumRRO Division No. 2 (Armor). The basis of this check was the lists of job requirements for various armored cavalry platoon personnel (2). The combat readiness check itself was designed to be used in evaluating the combat skills of armored cavalry platoon personnel. It contains task descriptions for individual platoon members, members working together in the squad and section, and members working together in the intact platoon.

In addition to the question of what skills are to be developed, two other important questions must be answered in developing a training program. The first of these, "Who is going to be trained?" has been predetermined by standard Army selection procedures and was therefore not considered in this study. The answer to this question determines to some extent the answer to the third question, "What methods and media will be used in effecting the training?"

This third question was the one chiefly considered in developing the training program reported here. The purposes, more specifically, were to translate from the language of the task description into a self-instructional pictorial training program, and to describe the methods and principles used in the translation.

DEVELOPMENT OF THE PROGRAM

Selection of Task

The care of a weapon was selected because this type of task is widely taught in the military. Of the weapons used by members of the armored cavalry platoon, the M-73 machine gun was selected because it was rated by a number of experts to be of intermediate difficulty.

First Translation Attempt

It has sometimes been assumed that a training program for a task can be developed from a verbal description of the task. This assumption was tested in the first translation attempt. Without previous knowledge of the M-73 machine gun, and with limited knowledge of other weapons, the authors attempted to learn the tasks of assembly, disassembly,

loading, unloading, and immediate action from the verbal descriptions and the weapon.

This initial attempt at translation with the original task description and the weapon failed because of the inadequacy of the verbal descriptors. An expert on the weapon had to be consulted before any methods or principles could be applied. This argued for the use of visual aids such as pictures as a means of effecting communication. A number of methods and principles, based for the most part on experimental evidence from research on film and programed instruction, were used in translating the modified task descriptions into the pictorial program.

Revision of Task Descriptions

Although the "Armored Cavalry Platoon Combat Readiness Check" was written to describe very small successive steps of performance, it was not considered necessary to teach the tasks in terms of this detail. The reasoning was based, for example, on the fact that the potential learners--adults--have already attained the muscular coordination required to manipulate the parts of the weapon. The task descriptions were therefore revised by combining small performance steps into larger, but still manageable ones. An example taken from the disassembly task is given below:

FIRST REQUIREMENT	ITEM (Disassembly)	Score (✓)	Score (0)
4.	Pushes all the way forward on the Cover Latch Rod with thumb of the left hand (on left side of the Receiver).		
a.	Ensures Cover Latch Rod stays locked in the forward position.		
b.	Lifts Cover with the right hand.		
c.	Pivots Cover all the way to the right to the open position.		

This fourth item was reduced to "Pushes the left Cover Latch Rod with the left hand until Cover unlocks, and pivots Cover open with the right hand."

The organizational structure of the task descriptions was defined in terms of gross categories--Disassembly, Assembly, Loading, Immediate Action, and Unloading. Research conducted by Northrop (3) and Sheffield and Maccoby (4), using instructional films, has shown that a more refined structure facilitates learning. The organizational structure of the tasks used here was therefore broken down into subtasks or natural units (4). The disassembly task, for instance, was broken down into the following functional subtasks: (a) hand charging the M-73 machine gun;

(b) inspecting the chamber; (c) checking barrel extension; (d) removing barrel assembly; (e) removing cover and feed tray; (f) removing guide rods and springs; (g) removing barrel extension; (h) removing breechlbock; (i) removing hand charger assembly.[1]

TRANSLATION TO PICTORIAL TRAINING PROGRAM

Design of Page Layout

The principles used in the design of the program were based for the most part on film research. The first principle used in the layout of pages was derived from research cited earlier (3, 4).

1. The principle was that one task element would be presented in a sequence.[2] (See Figure 1.) To present less than a task element or more than a functional task element, it was reasoned, would interfere with the smooth course of learning because the learner would have to interrupt the learning to turn a page.

The following principles were also used in the design of the page layout:

2. The subjective (learner's point of view) camera angle was to be used as much as possible (5). (See Figure 2.)

3. Photographs were to be taken to show the present state of the weapon rather than the state after the response is made (Figure 2.) This practice should make it easier to relate the picture to the weapon, since picture and weapon are then in the same state. (Directly relevant research evidence is not available.)

4. 'Blow-up" shots were to be used when the part to be manipulated was difficult to see with a full shot. These "blow-up" shots were to be presented as emanating from the full shot (Figure 3.). (Directly relevant research evidence is not available, but this appears logical.)

5. Relevant cuing and animation were to be employed to show the response to be made (6, 7, 8). (See Figure 3.)

6. The hands should be used in the photographs in the way they are normally used in the task, except when the grip is not particularly important and when the angle is photographically difficult (Figure 2). (Directly relevant research evidence is not available, but showing hands simply completes the image of the required response.)

---

[1]These functional subtasks can be described as discrete units and performed with minimal interdependence between subtasks.

[2]Here, the printed equivalent of a single sequence in film is defined as a page.

7. The names of the task elements were to appear at the top of the page and the names of weapon parts were introduced incidentally because knowledge of the names was not necessary to learning the relevant responses (Figure 1). (Directly relevant research evidence is not available, but it was assumed that the names would be learned incidentally and would not interfere with early performance.)

8. Verbal text was to be clear and simple (Figure 2).

Use of Page Layout

The page layouts were used by the photographers as guides in taking the photographs for the program. They were used as guides rather than as doctrine, because not all the information necessary to take the photographs was available in the layout. The particular angle had to be modified in some of the shooting, and additional minor decisions had to be made by the experimenter or the photographer.[3]

Photographic Facilities

The second floor of a temporary Army barracks was utilized for taking, developing, and printing the photographs (except for what was done at a professional photographic laboratory), and for testing the program.

To insure a relatively consistent background and easy manipulation of the weapon, an animation stand was constructed in the room. The stand was painted flat white and the sides of the wall were covered with flat white cardboard. Two flood lights illuminated the weapon, and the camera was mounted on a tripod.

TESTING THE PROGRAM

Subjects

Nineteen enlisted men served as subjects. Their ages ranged from 20 to 25 years; mean age was 21.5 years. Their General Technical (GT) scores ranged from 71 to 137; the mean was 106.2. Their Mechanical Aptitude (MA) scores ranged from 78 to 150; the mean was 103.2. All the Ss were assigned to duty at the US Army Armor Center, Fort Knox, Kentucky.

Design and Procedure for Program Development

A test of the program was designed and conducted to evaluate its effectiveness in communicating so as to elicit proper responses. The

[3]Technical Assistant Ronald Guy and Military Research Assistant Sp4 James L. Constantinides carried out the photographic work.

Installing the Hand Charger Assembly

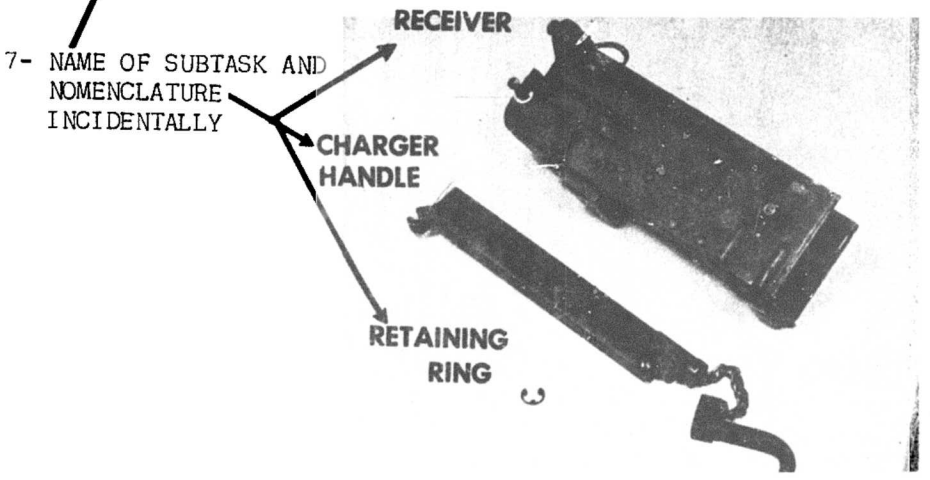
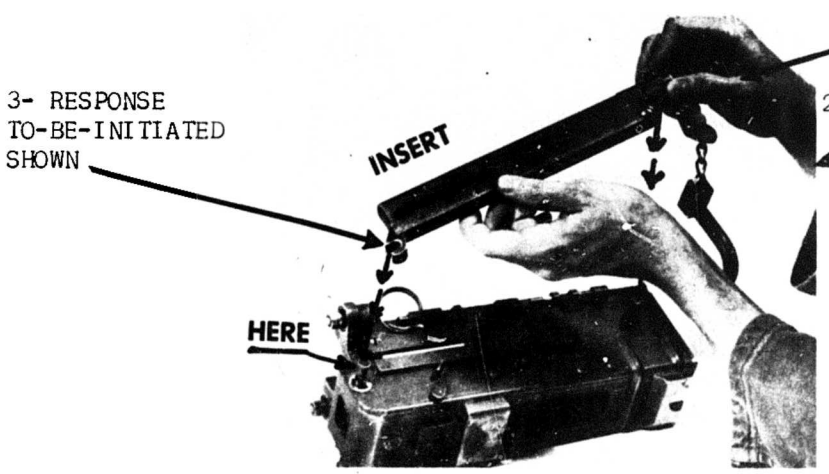
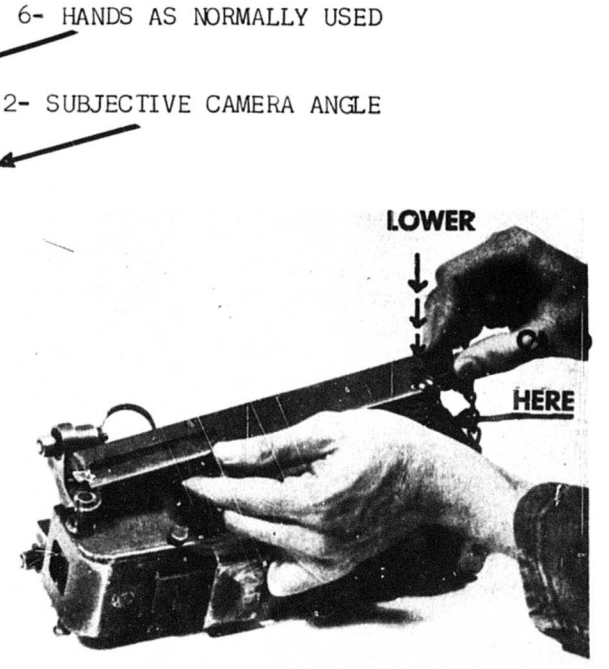


Figure 1



Insert the half moon cut of the charger assembly into buffer assembly pin.



Lower rear of charger assembly onto charger mounting stud.

Figure 2

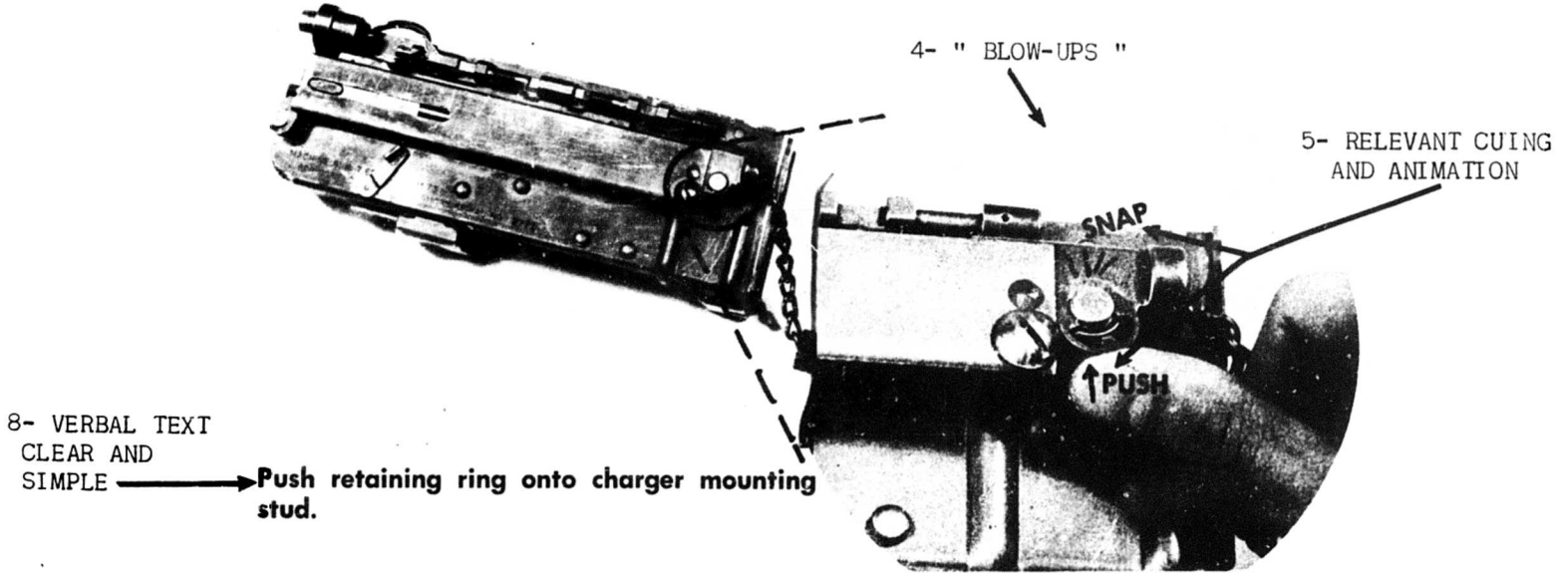

4- " BLOW-UPS "
5- RELEVANT CUING AND ANIMATION
SNAP
PUSH
8- VERBAL TEXT CLEAR AND SIMPLE
Push retaining ring onto charger mounting stud.

Figure 3

basic technique was to let S try to learn the tasks of weapon assembly and disassembly, unloading, immediate action, and loading, within two trials practicing by himself and using only the self-instructional program and the weapon. During his attempts, both the subject and the program were observed, and areas of difficulty were recorded. The program was revised three times (after the fifth, ninth, and fourteenth Ss) wherever it was apparently not communicating. After being trained, the Ss were tested; each trainee was required to complete each task without using the program.

To consider the data, the Ss are to be divided into four groups (Group 1, Ss 1-5; Group 2, Ss 6-9; Group 3, Ss 10-14; Group 4, Ss 15-19), according to the program revision they used. Also the procedure for administering the training was varied slightly for the four groups. In Groups 1 and 2 each S completed Trial 1 in the morning and Trial 2 in the afternoon. One week later, each S in Groups 1 and 2 completed a Criterion Test and a Retest, both without the book and both in the morning. Learning trials for Group 3 were completed in the same manner as those for Groups 1 and 2. But Group 3 took the Test the same day as they did the learning trials, and the Retest a week later. Group 4 also completed both learning trials in one day, but unlike the other groups, Group 4 completed each subtask twice before going on to the next subtask. In other words, they completed Trials 1 and 2 in one sitting; also they took the Criterion Test the same day (Because the trainees were transferred to another post, Group 4 did not take the Retest.) The order of learning the task elements was as follows: Groups 1, 2, and 3--assembly, disassembly, loading, unloading, immediate action; Group 4--disassembly, assembly, loading, immediate action, unloading.

RESULTS

The mean time scores for the individual groups on all tasks for Trials 1 and 2 are shown in Figure 4. The total completion time for Trial 1 varied from 28 min., 6 sec. (for Groups 1 and 2) to 23 min., 38 sec. (for Group 4). The average time for all groups combined was 26 min., 35 sec. The change in average total time for all groups from Trial 1 to Trial 2 was most striking; average time saved was 16 min., 35 sec. Results of the statistical analysis of the difference between Trials 1 and 2 for the four groups is shown in Table 1.

Table 1

Results of Correlated *t*'s Computed on
Performance Time Scores Between Trial 1 and Trial 2

Group	*t*		P
1 and 2	7.03*	<	.001
3	4.23*	<	.001
4	4 07*	<	.001

Figure 5 shows the time scores for each task for each group. The only large difference occurred between the first three groups and Group 4 on weapon assembly. It seems reasonable to attribute this difference to the fact that for Group 4 the order of learning the tasks was changed, the disassembly task being performed first.

The time scores for the Test and the Retest are also shown in Figure 4. (Group 4 took only the Test.) The Test scores were quite similar to those on Trial 2. Further learning apparently took place between the Test and the Retest, because the time scores for the Retest were also reduced, although the change was small.

Correlations were computed to determine whether any relationship existed between intelligence, as measured by the GT score, and learning, and between the MA score and learning. (GT scores and MA scores were obtained from the trainees' Form 20's.) The measure of learning was determined from a difference score between Trial 1 and the Test. The Retest would have been more appropriate, but Group 4 did not take the Retest. Further, the differences between the scores on the Test and the Retest were not marked. The correlation between GT and learning (.24) was not significant (N = 19). Similarly, the correlation between MA and learning (.34) was not significant (N = 18). Although these correlations are not statistically significant, the trend is in the expected direction.

The assist scores, which were additional measures of learning, were recorded during the Test and the Retest. An assist was recorded when the trainee required help to complete a subtask. There were thirty subtasks constituting the five major tasks. The assist scores revealed no trends (and no significant differences) either across groups or from Test to Retest. The average number of assists was 4.16 for the Test and 4.21 for the Retest, but the numbers seem so small as to be inconclusive.

Additional results were furnished by the US Army Infantry School (Fort Benning, Georgia). Fourteen soldiers who had no experience with M-73 were given the programed booklet and were instructed to complete the tasks. Without assistance from anyone, all 14 soldiers completed all tasks. The average time was 12 min. for Trial 1 and 3 min. for Trial 2. The Infantry School "considers it feasible to incorporate this method of instructing disassembly and assembly in weapons field manuals." (See Appendix for copy of Intantry School letter.)

DISCUSSION

The results of testing the program are encouraging both statistically and nonstatistically. The performance time between Trial 1 and the Retest was reduced by more than half. The performance time reduction between Trials 1 and 2, however, was even more drastic. We could infer from these results that the trainees learned--learned quickly. Also important, however, are the experimenters' observations of the trainees (though such

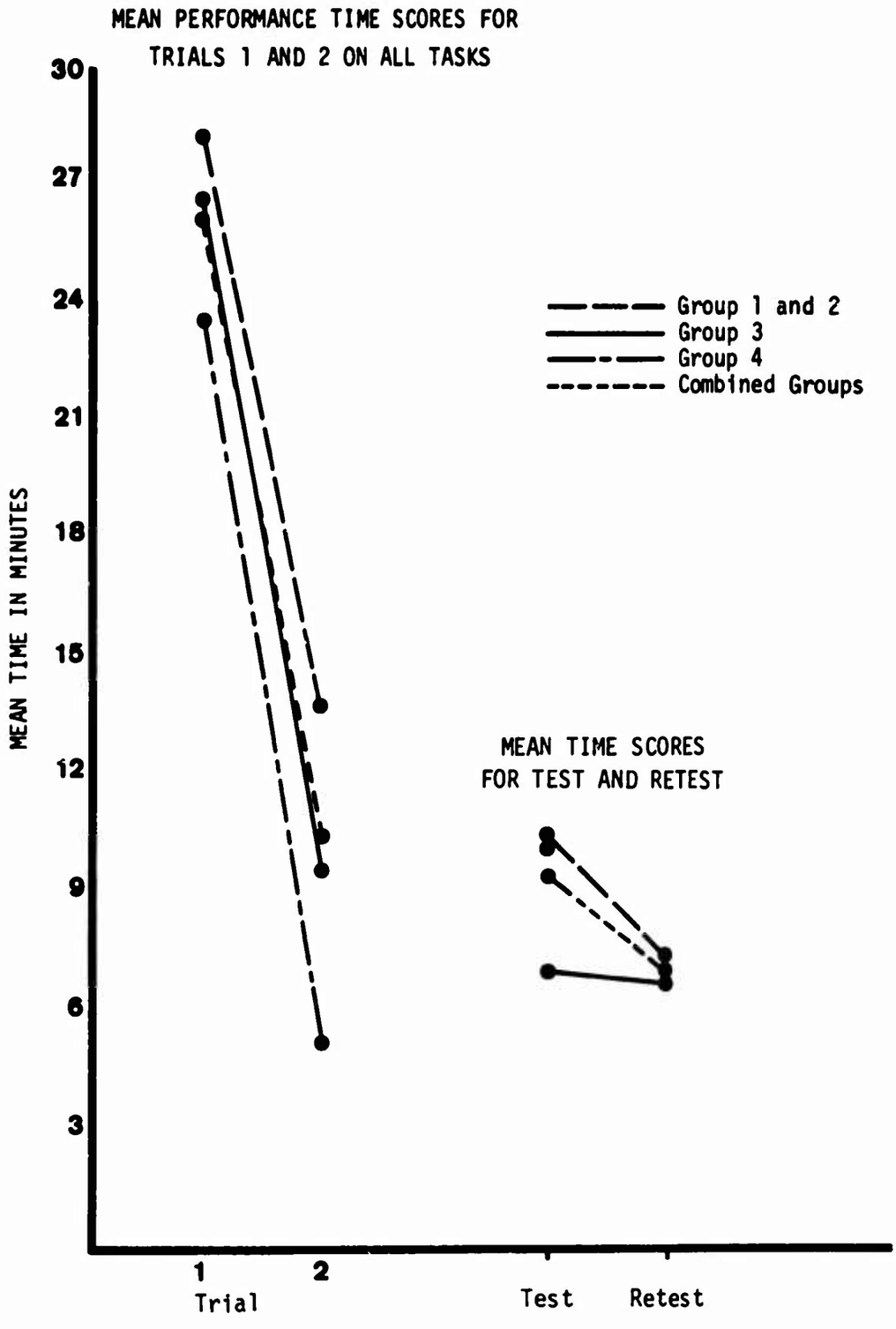

MEAN PERFORMANCE TIME SCORES FOR
TRIALS 1 AND 2 ON ALL TASKS
30
27
24
21
18
15
12
9
6
3
MEAN TIME IN MINUTES
Group 1 and 2
Group 3
Group 4
Combined Groups
MEAN TIME SCORES
FOR TEST AND RETEST
1
2
Trial
Test
Retest

Figure 4

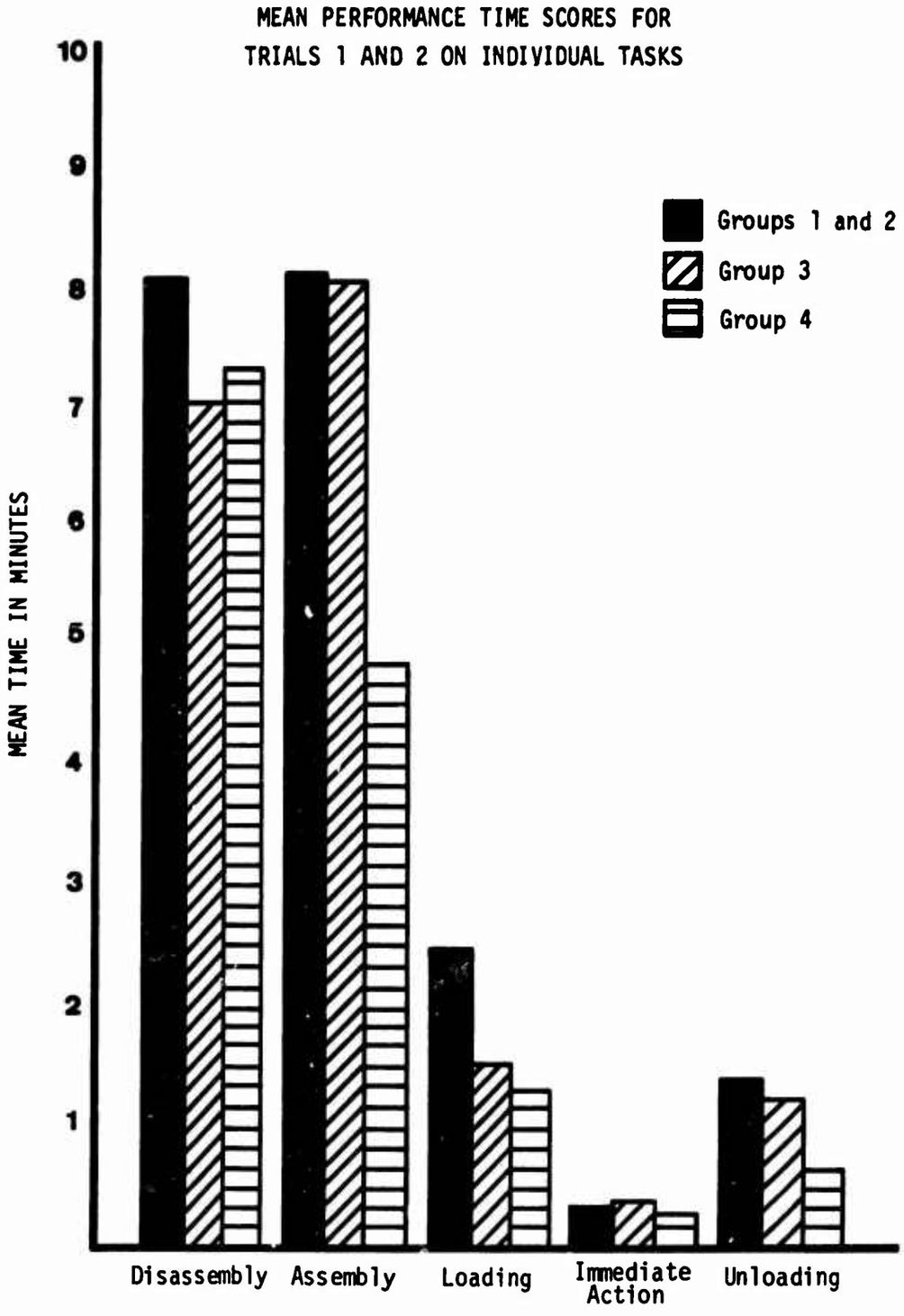

MEAN PERFORMANCE TIME SCORES FOR
TRIALS 1 AND 2 ON INDIVIDUAL TASKS
MEAN TIME IN MINUTES
10
9
8
7
6
5
4
3
2
1
Groups 1 and 2
Group 3
Group 4
Disassembly
Assembly
Loading
Immediate Action
Unloading

Figure 5

observations are not usually considered). The authors observed that the trainees were enthusiastic about the program. The trainees suggested that they seemed to learn the tasks much more easily than usual. They also suggested that the method of training ought to be emphasized in the Army, and that it was much more interesting and easier than listening to and watching some instructor do the tasks.

Although the results appear encouraging, the program was not compared with another method of training. Therefore, nothing can be said about the relative merits of this training program compared with either the traditional demonstration type of training or other types of training. However, in the Infantry School test and comments, there appears to be recognition of this technique as a valuable adjunct to current methods of shaping student performance. Under the kind of pictorial program used in the present effort, the trainee can work at his own pace, whereas self-pacing is not possible under the demonstration method.

The authors' learning experience in developing the program may be important to those who will be considering the use of task descriptions in a similar program effort. The authors were relatively naive beforehand about the principles of programing,[4] and particularly those of pictorial programing in which, indeed, there has been little research. Some film research was conducted at the Pennsylvania State University under a contract with the US Naval Training Device Center during the early 1950's. Lumsdaine and others (6) have also conducted considerable research on training films. This report has been an attempt to provide the would-be pictorial programer with a sample of the kind of work which may be useful.

[4]Informal instruction was obtained from two colleagues, Dr. Elmo E. Miller and Dr. Paul G. Whitmore, who are experienced in the field of programing. Once the authors were started, Dr. Miller provided valuable assistance up to the page layout stage. However, further technical assistance was not requested.

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"COPY OF INFANTRY SCHOOL LETTER"

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AJIIS-D(t) (3 Jun 66) 1st Ind
SUBJECT: Pictorial Instructional Program for the M-73 Machine Gun

Headquarters United States Army Infantry School,
Fort Benning, Georgia 31905 27 June 1966.

TO: Commanding General, US Continental Army Command,
ATTN: ATIT-RD-RD, Fort Monroe, Virginia 23351.

1. The pictorial instructional program for the M-73 machine gun was evaluated by this school.

2. A limited performance test of the program was conducted by USAIS during the period 15-17 Jun 66. The test consisted of having 14 M-73-naive soldiers attempt, without assistance, the tasks shown on the booklet. Results of the tests were as follows:

a. 100% of tested personnel completed all tasks.

b. Average time for first trial - 12 minutes.

c. Average time for second trial - 3 minutes.

3. USAIS comments on the pictorial instructional program booklet are attached as inclosure 1.

4. This school considers it feasible to incorporate this method of instructing disassembly and assembly into weapons field manuals.

FOR THE COMMANDANT:

EDWARD J. McKITRICK
LTC, Infantry
Act Asst AG

1 Incl
incl 1 and 2 wd
added
3. DA Form 1598 (dupe)

PART II

DEVELOPMENT OF A PICTORIAL INSTRUCTIONAL PROGRAM FOR THE CALIBER .45 AUTOMATIC PISTOL

Elmo E. Miller

MILITARY PROBLEM

The Caliber .45 Automatic Pistol is the one most widely used in the Army; consequently, there is much to gain if one can get effective instruction on disassembly/assembly of this weapon without using instructors. Self instruction on the weapon is also critical because it often is not feasible to have a formal training course for men using the weapon, and sometimes there is no one who has had experience with the weapon available to advise the beginner.

OBJECTIVE OF THE DEVELOPMENT

The objective was an effective training package rather than research results. This emphasis led to an abbreviation of the task description and program development, and less formal documentation of the process. One of the main purposes of this report is to describe the "picture guide" method for training administrators or technical writers who might want to use the technique for their immediate, practical training problems; thus, we will indicate the respective roles of the people directly involved, as well as the procedures used.

METHODS AND PROCEDURES

The Project Officer first became thoroughly familiar with the task, by reading a task description in the existing manual, and by being tutored by an experienced instructor in disassembly/assembly of the caliber .45 pistol. This weapon presents a rather difficult task, because the picture guide was to cover both general and detailed disassembly/assembly. The format was to be organized in such a way that the detailed disassembly would be an option, depending upon the condition of the weapon. Some of the operations required severe force or tricky manipulations, so that a man would not be likely to discover the sequence by trial and error, even if he were generally familiar with weapons.

The task was not formally and explicitly defined in writing As the Project Officer discussed and demonstrated each step of the task with the HumRRO Consultant on Pictorial Programing, they agreed on a tentative page layout, while the Consultant took brief notes and made rough sketches to guide the photographing and page composition

Upon completion of plans for composition of material, the photographing was scheduled; the photography for the first version consisted of over 200 shots, which were all taken in one day. After the prints were developed, a full-size draft was prepared by trimming the desired pictures and gluing them to poster board with rubber cement. The stiff poster board facilitates handling and modifications. The poster board draft was used throughout the development phase, and as a guide for the illustrator on the final draft.

When the first poster board draft was complete, the Project Officer and Consultant tested all sections on several men to see whether the picture guides were clear enough to guide practice for men who had no previous experience with the pistol. Wherever there was difficulty, modifications were designed and new pictures were taken. The Project Officer subsequently made further smaller-scale tests and revisions of the draft until he was satisfied with its effectiveness for training. From this draft the illustrator composed the final version, using fresh enlargements from the original negatives. The final picture guide for disassembly/assembly occupied eighteen pages; thus the pictorial presentation required only a modest amount of space.

In composing a draft which would subsequently be tested with students and modified, two general policies were followed: (a) When in doubt, use the most concise presentation being considered, because omissions will be detected later whenever a student fails to perform that step in the procedure. (b) Do not attempt to anticipate all possible difficulties for the learner, but compose the draft rather rapidly, relying upon tryouts with learners to reveal ambiguities. It is surprisingly difficult to anticipate where a person will or will not experience difficulty; yet when a man is actually observed having difficulty, it is relatively easy to understand why.

VARIATIONS IN PICTURE GUIDE TECHNIQUES

The general principles and techniques have been described in Part I of this report under "Design of Page Layout." (See p. 5). However, there were some notable additions or refinements of techniques.

1 and 2. Clustering, and Using a "Path"

Perhaps the two most significant additions involve the organization of the pictures on the page: The pictures are arranged in clusters to show a succession of views within each step, and the clusters are connected by a shaded "path" to indicate the order in which a sequence should be performed. Figure 6, for example, shows one page from the detailed disassembly program; note that the small parts being removed are shown in separate photos, as well as in the main picture. These small pictures clearly indicate what part is being removed, and the double views (connected by dotted lines) did not seem to confuse the soldiers on whom the program was tested.

Figure 7 illustrates a variation in the clustering technique, showing the recoil spring plug being replaced during the general assembly procedure. In this cluster the successive views show the weapon at various stages within a step. Note that the pictures for the manual are rather severely cropped, in part to save space, but primarily to focus attention on the critical area, and to facilitate comparisons from one

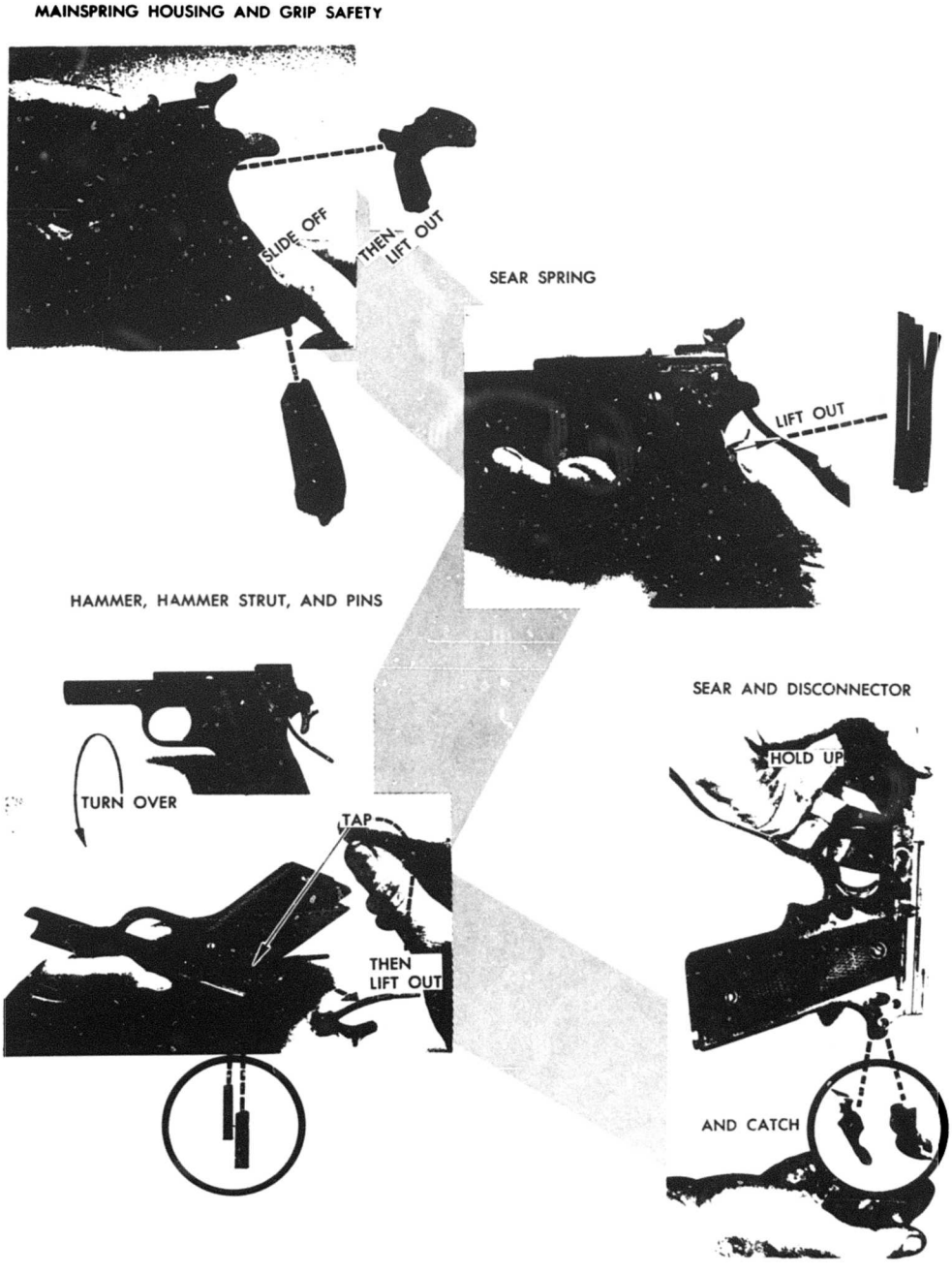

Figure 6. One Page from the "Detailed Disassembly" Program. This page illustrates generally the use of clusters of pictures to indicate the removal of parts, and the use of the gray "path" to lead the student from one cluster to another in correct sequence.

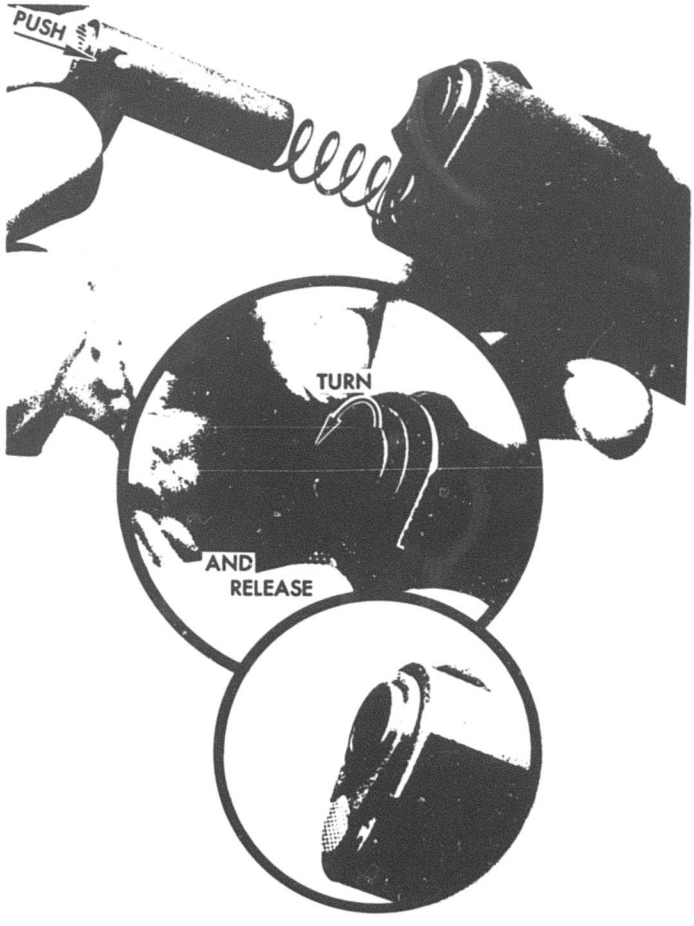

Figure 7. One Cluster from the "General Assembly" Program, showing the weapon in successive stages during replacement of the recoil spring plug.

picture to the next. The final picture in the cluster shows the terminal position, and when this picture is considered in relation to the previous view, it shows exactly how far the barrel bushing should be turned. Thus, the clustering of pictures avoids the dilemma of whether to show the weapon before or after the action, by showing both. (See page 5, Part I of this report, "Design of Page Layout," Rule 3.) Of course the close-cropped pictures used in the clustering technique would not be feasible if the constant camera angle were not maintained.

The gray path connecting the clusters indicates the correct sequence of steps, but without burdening the soldier's attention. An alternative sequencing code might be to number the pictures in the order in which they should be considered, but reading the numbers does require some attention. In our experience, if we used sequence numbers, the men sometimes would perform the steps out of order in spite of the numbers, but the gray path seems to communicate the sequence reliably.

3. Succinct Treatment

Another notable feature of this program is the very radical reduction in the number of words used, even compared to the M-73 program. The name of each part is given only as a title, when that part is being removed or replaced. Almost all the words on the pictures are verbs, telling the soldier what to do. The written text did not describe the tasks. Thus the pictures are an absolutely essential channel of information to the soldier, and not merely an accessory to the written text.

The words on the pictures also may indicate sequence of operation, as in Figure 6, first cluster, "slide off--then lift out." Note also the rather peculiar slant on these words, in order to insure their being read in the proper order; had the words appeared on the appropriate dotted lines, the soldier, reading from top to bottom, would have read them in the opposite order.

4. Animation

As in the M-73 program, animation was used extensively to call attention to relevant cues and to indicate the desired action. Another noteworthy animation technique is the extensive use of chalk to emphasize the highlights of the weapon, especially where the highlights are a cue for that part of the task. For example, in Figure 8, second view, note that the notch is sharply delineated by chalk along the edge

5. Grip

The hands generally were shown (as in the M-73 program) using a rather natural grip. However, the grip sometimes had to be modified

somewhat, to prevent obscuring a critical cue. For instance, in Figure 7, the finger does not entirely cover the end of the plug. Also, if the other fingers appear at all, it should be made apparent that they are not manipulating anything. For instance, in Figure 8, the left thumb does not appear on the safety lock until the second view, when it must perform the action.

6. Repositioning the Weapon

Another variation in technique was used because the pistol is a relatively mobile weapon in contrast to the M-73. If the weapon was turned over, or otherwise repositioned, the change was indicated explicitly, especially when it seemed likely that the soldier might make a mistake; for example, in Figure 6, third cluster, "Hammer, Hammer Strut, and Pins," the "turn over" was shown explicitly, because if the other side of the pistol were placed down, the pins would not drop out as indicated, because of a small flange on one end of each pin. On the other hand, repositioning the weapon may involve little chance for error, and therefore need not be indicated in detail; for instance, in the last cluster of Figure 6, entitled "Sear and Disconnector," all that is required is that the pistol be pointing upward; so detailed directions are not needed.

7. Teaching Difficult Steps

Difficult manipulations may require warnings and perhaps alternative methods. Figures 9 and 10 provide two illustrations of the picture guide method applied to rather difficult manipulations. In Figure 9 ("Safety Lock"), the "half-way position" is tricky because it is an unstable equilibrium, with spring pressure tending to force the lock either up or down. Also, sometimes there is need for an alternative method, pressure from the other side, but this alternative is given last, to use in case the simpler method is not adequate. The fact that there are several times the usual number of words here should help to alert the soldier to the difficulty of the operation. The step in Figure 10 is difficult because of the amount of force needed, and soldiers are apt to be afraid of damaging the weapon unless they are aware of the force needed.

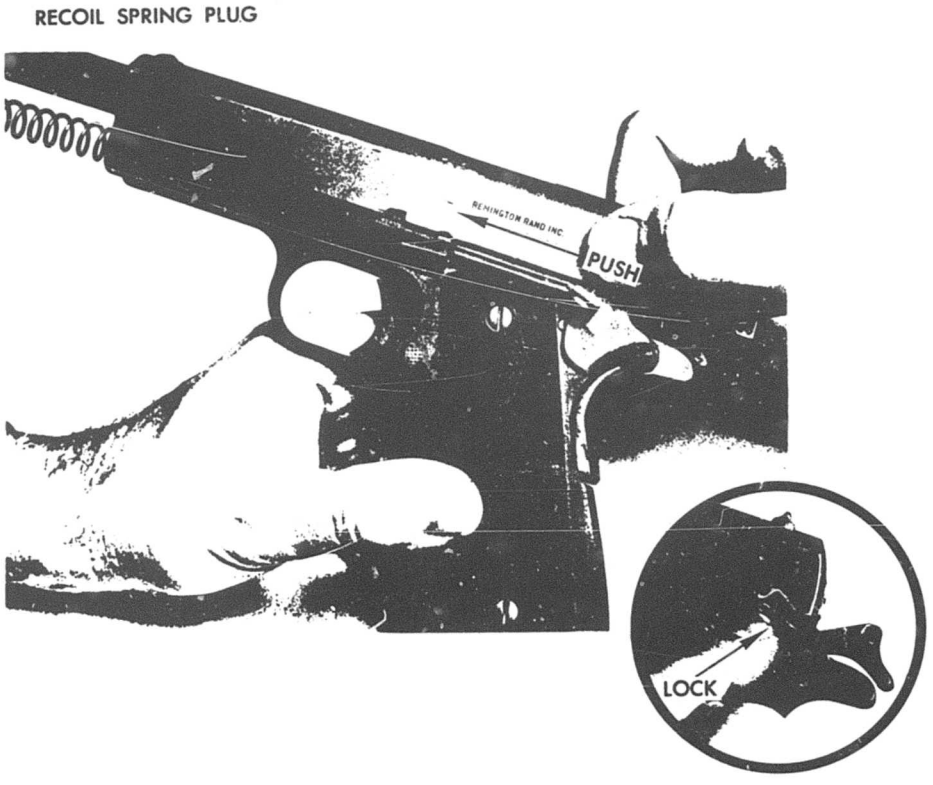

Figure 8. A Cluster Illustrating "Highlighting" As an Animation Device.

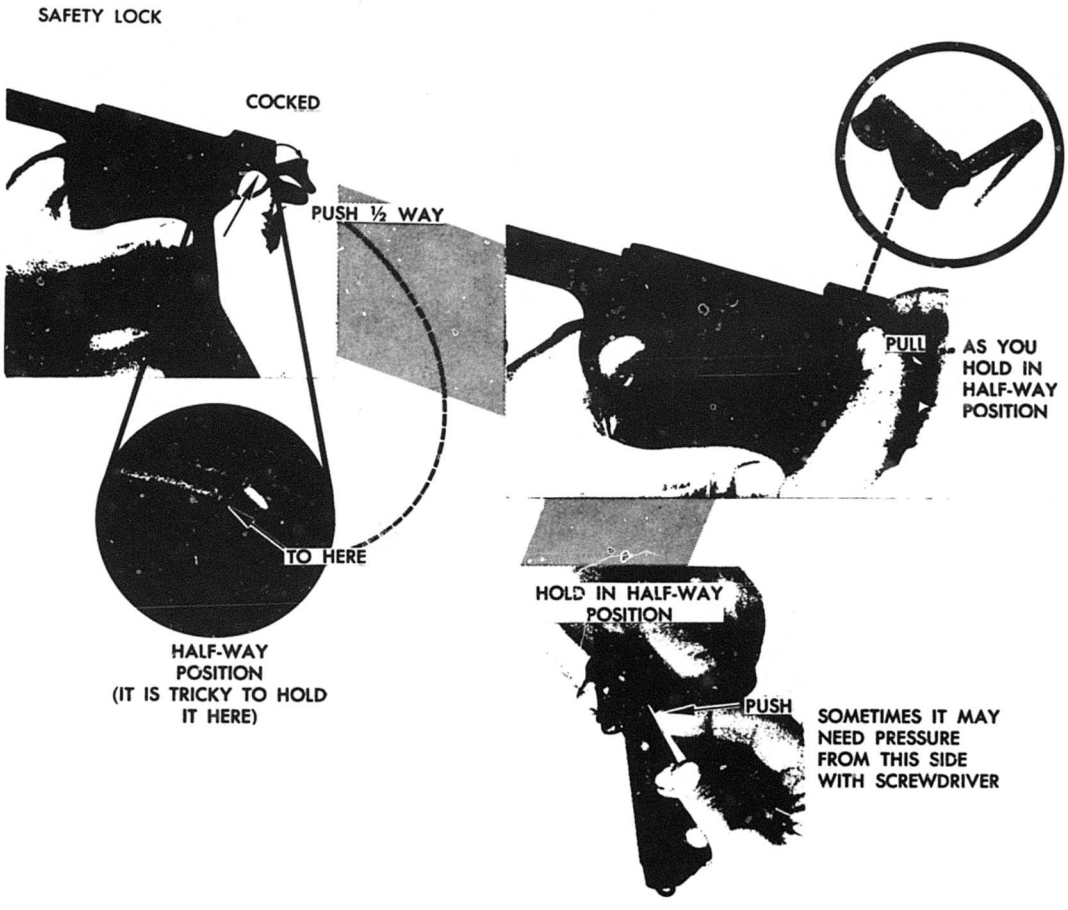

Figure 9. Instruction for a Difficult Step. Spring pressure produces unstable equilibrium at the "half-way position," and the safety lock is hard to grasp and pull out.

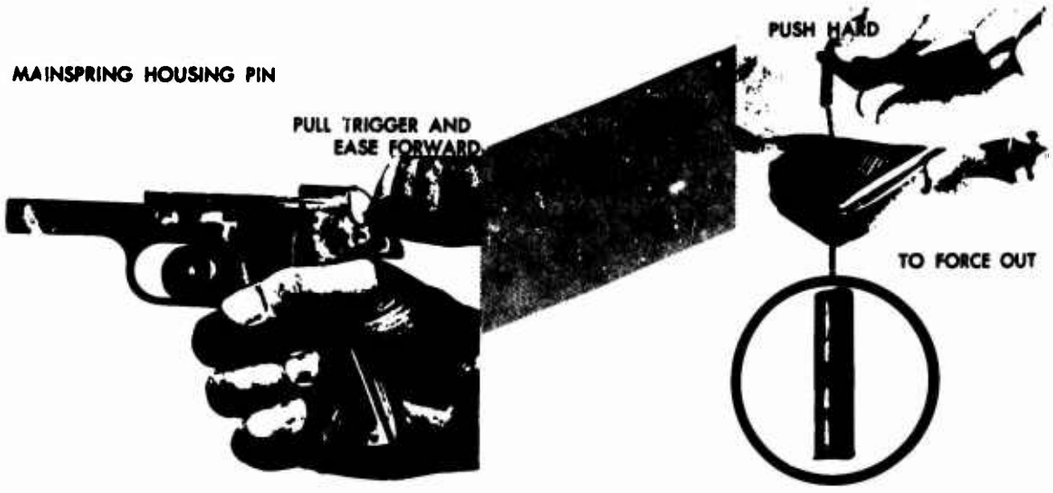

Figure 10. Instruction for Another Difficult Step. Pushing out the pin requires considerable force.

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13. ABSTRACT

This report presents the results of two efforts in improving the effectiveness of pictorial guide techniques. Part I describes the development and evaluation of a pictorial programed training aid for disassembly/assembly of the M-73 machine gun; it was developed to illustrate the translation of a task description into an effective training program. Part II describes the subsequent development of a similar "picture guide" for the disassembly/assembly of the caliber .45 automatic pistol, M1911A1.

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